10/501191

19 Rec'd PCT/PTO 15 FEB 2005

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"Holding device for the arrangement of an optical component in front of a laser light source and such an arrangement and a process for producing such an arrangement"

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This invention relates to a holding device for the arrangement of at least one optical component in front of a laser light source of a laser unit, comprising a first holding part to which at least one optical component is attached. Furthermore this invention relates to an arrangement of at least one optical component in front of a laser light source of a laser unit with such a holding device. Furthermore this invention relates to a process for producing such an arrangement.

A holding device and an arrangement of the aforementioned type have been known for a long time from the prior art. For example, the laser light source can be made as a semiconductor laser, especially as a laser diode bar. The laser unit which comprises this laser diode bar is generally made such that the laser diode bar is mounted on a heat sink. The optical component which is to be placed in front of the laser diode bar is usually made as a fast-axis collimation lens which must be positioned relatively exactly in front of the laser diode bar in order to achieve unobjectionable beam quality. According to the prior art, a first holding part is cemented for example to the heat sink for this positioning. The optical component which is made as a fast-axis collimation lens can be cemented to this holding part at the corresponding given position. Usually a cement which can be cured by UV radiation is used here.

The disadvantage in such a holding device or such an arrangement is that before curing of the cement the optical component can be positioned very exactly in front of the laser diode bar so that a beam of the desired quality results before curing. But the curing of the cement slightly shifts the optical component relative to the laser unit and thus relative to the laser light source, so that with the holding devices known from the prior art only beam qualities of laser light sources which do not often meet requirements can be achieved. Another disadvantage is the often

different coefficient of expansion of the heat sink, the cement and the holding device so that when temperatures change the positioning of the optical component in front of the laser light source is likewise disturbed.

The object of this invention is to devise a holding device and an arrangement of the initially mentioned type which ensure more accurate and more stable positioning of an optical component in front of a laser light source. Furthermore the object of this invention is to devise a process for producing such an arrangement.

These objects are achieved with respect to the holding device by the characterizing features of claim 1, with respect to the arrangement by the characterizing features of claim 8, and with respect to the process by the characterizing features of claim 12.

Claim 1 in its characterizing part calls for the holding device to furthermore comprise a second holding part which is attached to one part of the laser unit, the first holding part being attached to the second holding part. As a result of the fact that two holding parts which are to be joined to one another are being used, different coefficients of expansion of the materials used can be equalized. Furthermore, the two holding parts which are connected to one another can be shaped and positioned such that the displacements to one another which arise when connecting agents such as cement or solder cure equalize.

With the process as claimed in the invention, in one process step the first holding part can be joined to the first optical component and in a second process step the second holding part can be joined to one part of the laser unit. Subsequently the first holding part can be joined to the second holding part. Such a process offers the advantage that the first holding part is cemented to the optical component and the second holding part is cemented to one part of the laser unit, these

cemented connections being cured. Only subsequently are the two holding parts joined to one another, and before curing of the cement which joins these two holding parts to one another the optical component can be positioned exactly in front of the laser light source. Instead of cement connections, solder connections can also be used.

Here it can be provided especially that one of the holding parts has a connecting section which is surrounded at least in sections by the receiving section of the other of the holding parts. For example, the second holding part can have a connecting section which is surrounded at least in sections by the receiving section of the first holding part. By surrounding the connecting section of one of the holding parts by the receiving section of the other of the holding parts the forces which occur when the cement or the solder cures are distributed more uniformly in different directions so that de-positioning by the curing of the cement or of the solder is reduced.

In particular, the connecting section can have an essentially cylindrical outside contour, the receiving section having an essentially hollow cylindrical inside contour, the connecting section being placed at least partially in the receiving section. Here there can be an annular intermediate space between the outside contour and the inside contour. This intermediate space can be filled preferably at least partially with cement or solder. Based on the rotationally symmetrical coaxial configuration of the receiving section and connecting section the forces which occur when the cement which is located in the intermediate space cures can be comparatively exactly cancelled out. With the holding device as claimed in the invention the optical component can be positioned exactly in front of the laser light source such that the beam quality of the light which emerges from the laser light source is drastically improved. For example, the beam quality can be improved such that the laser light is coupled into the glass fiber

much better, for example, with respect to its energy density, 40% better.

The annular intermediate space which can be partially filled with cement or solder can have a radial dimension of 10 microns to 200 microns, preferably of roughly 50 microns. The displacements which are possible when the cement cures are further minimized by this very small intermediate space.

According to one preferred embodiment of this invention, an intermediate layer is inserted between the part of the laser unit to which the second holding part is attached, and the corresponding contact surface of the second holding part. This intermediate layer can be for example heat-insulating so that the first and the second holding part are less influenced by the heating-up of the laser unit.

With respect to the arrangement as claimed in the invention it can be provided that the laser unit as the laser light source comprises a laser diode bar or a stack of laser diode bars.

In particular, the part to which the second holding part is attached can be a heat sink. The first optical component can be made as a fast-axis collimation lens. Furthermore it is possible for the second optical component which is made especially as a slow-axis collimation lens to be held on the laser unit via lateral support elements.

With respect to the process as claimed in the invention, it can furthermore be provided that the hollow cylindrical inside contour is applied to the cylindrical outside contour and is cemented or soldered to it. In doing so, after application of the inside contour to the outside contour the first optical component can be positioned in front of the laser light source, in a subsequent process step the cement which joins the outside contour and the inside contour being cured, and this curing can take place for example by UV irradiation. Based on the

aforementioned coaxially rotationally symmetrical configuration of the inside contour and outside contour, after exact positioning of the optical component in front of the laser light source only very small displacements of the component relative to the laser light source will take place, because the forces which occur during curing can be compensated.

Other features and advantages of this invention become clear based on the following description of preferred embodiments with reference to the attached figures.

Figure 1 shows a perspective view of the arrangement as claimed in the invention with a holding device as claimed in the invention;

Figure 2 shows another perspective view of the arrangement with the holding device as shown in Figure 1;

Figure 3 shows a side view of the arrangement with a holding device as shown in Figure 1;

Figure 4 shows a view as shown by the arrow IV in Figure 3;

Figure 5 shows a side view of another embodiment of an arrangement as claimed in the invention with a holding device as claimed in the invention;

Figure 6 shows a detailed view as shown by the arrow VI in Figure 3;

Figure 7 shows a detailed view as shown by the arrow VII in Figure 4;

Figure 8 shows a view as shown by the arrow VIII in Figure 5;

Figure 9 shows a sectional view as shown by the arrows IX-IX in Figure 8;

Figure 10 shows a detailed view as shown by the arrow X in Figure 9.

The arrangement shown in Figure 1-4 comprises a laser unit 1, a holding device 2 as claimed in the invention and as well as a first optical component 3 and a second optical

component 4. The laser unit 1 comprises a laser light source 5 which is made as a laser diode bar in the embodiment shown. Alternatively, a laser light source 5 can also be made as a stack of laser diode bars. The laser diode bar which is used as a laser light source 5, as is shown especially in Figure 6 and Figure 10, is mounted on the heat sink 6.

The first optical component 3 is made as a fast-axis collimation lens in the illustrated embodiment. The second optical component 4 in the illustrated embodiment is made as a slow-axis collimation lens. This slow-axis collimation lens, as is shown in Figure 1, Figure 2 and Figure 5, has individual lens sections which are assigned to individual emission centers of the laser diode bar in the transverse direction of the laser light source 5.

In the illustrated embodiment as shown in Figure 1 to Figure 4, the second optical component 4 is held by lateral support elements 7 which in the illustrated embodiment are attached to the heat sink 6 and proceeding from its outside extend to the right in Figure 3. These two lateral support elements 7 form outer lateral supports on which the outer lower edges of the second optical component 4 rest. This is shown especially in Figure 1, Figure 2 and Figure 7.

In Figure 5 and Figure 8 to Figure 10 the lateral support elements 7 are omitted in order to make the features associated with the holding device as claimed in the invention more clear.

The holding device 2 as claimed in the invention, as is apparent especially from Figure 10, comprises a first holding part 8 which holds the first optical component 3, and furthermore a second holding part 9 which is connected to one part of the laser unit 1, specifically to the heat sink 6. The second holding part 9 has a connecting surface which faces the heat sink 6 and which is cemented or soldered for example to the surface of the heat sink 6 facing the second holding part 9. Alternatively it is also possible to provide an intermediate layer which consists for

example of a heat-insulating material between the heat sink 6 and the connecting surface of the second holding part 9.

On its side facing away from the heat sink 6 the second holding part 9 has a cylindrical outside contour 10. This cylindrical outside contour 10 is surrounded by the hollow-cylindrical inside contour 11 of the first holding part 8 in the interconnected state of the two holding parts 8, 9. Before the two holding parts 8, 9 are fixed to one another, between the outside contour 10 and the inside contour 11 there is an annular intermediate space 12 which can have a very small radial dimension of 50 microns, for example.

The hollow cylindrical inside contour 11 is made on the first holding part 8 in one leg 13 of the holding part 8 which extends underneath the first optical component 3 which is made as a fast-axis collimation lens, over its entire width. From this transversely running leg 13 there extend outer lateral vertical legs 14 up in Figure 5 which are joined to the upper contact leg 15 which extends on the top of the first optical component 3 over its width. Another lower contact leg 16 is directly connected to the transversely running leg 13. The two contact legs 15, 16 between over a large part of the width of the first optical component 3 which is made as a fast-axis collimation lens [sic] leave exposed the optically functional cylinder surfaces of the first optical component 3, so that the laser light emerging from the laser diode bar can be collimated with respect to its fast-axis divergence.

The arrangement as claimed in the invention can be produced by the second holding part 9 being attached to the laser unit 1 in a first process step. This can take place by cementing or soldering the contact surface of the second holding part 9 to the heat sink 6. Optionally an intermediate layer can be inserted between the heat sink 6 and the contact surface. In another

process step the first optical component 3 can be attached to the first holding part 8 for example by cementing. Subsequently the hollow cylindrical inside contour 11 of the first holding part 8 is applied to the cylindrical outside contour 10 of the second holding part 9, and the cylindrical outside contour 10 can be covered beforehand with a cement. Subsequently the first optical component 3 can be positioned exactly in front of the laser light source 5. Subsequently the cement can be cured for example by illumination with UV light.

Alternatively the intermediate space 12 can be filled with solder and the optical component 3 can be positioned exactly in front of the laser light source 5 before hardening and curing of the solder.

As a result of the fact that the cement or the solder essentially completely fills the intermediate space 12 which is made annular or in the shape of a cylindrical shell, if necessary the forces which arise during curing are essentially cancelled so that by curing the cement no noticeable displacements of the first holding part 8 relative to the second holding part 9 occur.